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ABSTRACT

Eye movements and comprehension were examined when good and poor seventh graders read materials which contained cloze deletions and read comparable nontreated materials. The number of fixations and regressions increased when good readers read cloze materials. Good readers demonstrated superior comprehension under both treatments. Good readers apparently react to mission or uncertain cues by searching for additional cues whereas poor readers maintain a constant pattern of cue selection, regardless of the nature of the materials. (Author)

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INFORMATION PROCESSING STRATEGIES OF GOOD AND POOR READERS AS EVIDENCED BY EYE MOVEMENTS

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In concert with the interest among investigators in the use of the cloze technique as an indicator of the readability of prose, the writers have attempted to compare the eye movements of good and poor readers as they encountered cloze-treated materials. Since successful reading of these materials seems to depend on the ability of the S to supply the information which had been conveyed by the deleted words, the procedure seemed to offer a situation where the need for guessing strategies would be heightened. When the eye movements of readers were recorded while these strategies were being used, it seemed likely that the E's would be able to identify the ocular patterns of this behavior in contrast with situations where the patterns would be more subtle, situations where the prose materials were not mutilated by deletions.

The cloze technique for determining readability involves the deletion of words from prose selections according to some scheme of the E. Deletions may be made in intervals of five to ten words; they may also be made where specific parts of speech occur. The procedure has been used to rate materials by Bormuth (1967), Taylor (W. Taylor, 1959) and many others. Some have suggested its use as an indicator of the reader's ability to comprehend materials (Kennedy and Weener 1973; Tuinman, 1971). In the present study, the procedure was used to create situations in which both good and poor readers were engaged in what Weaver suggested as a "search procedure" (Weaver, 1965).

The investigations of Taylor (S. Taylor, 1960) involving eye movement photography also led him to conclude that mature readers engage in an active search when they are puzzled by difficult or obscure syntax and vocabulary; the search was characterized by a flurry of regression and subsequent sweeps. In an early study, Boyle suggested that such activity is necessary for successful reading

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(Boyle, 1942). This kind of behavior seems to support the notion of reading as a process of choosing probable utterances based on cues contained in the text (Goodman, 1968; Hochberg & Brooks, 1970). Under cloze conditions, it might be expected that the search behavior of good readers would be accentuated. More regressions and fixations would occur during the reading of cloze materials. This study was an attempt to verify that hypothesis and to determine what poor readers would do under the same conditions.

Definition of Terms

To clarify the terminology as used in this study to follow definitions might be helpful.

A. Cloze technique - The deletion of every sixth word from selected prose passages. A blank space was left which was the same width as the deleted word.

B. Saccadic movements - The apparent movements of the eye as represented by reflected light from the pupils. These are classified as:

   1. Sweeps. The rapid movement, left-to-right, between points on a line of print.
   2. Fixations. Pauses where the eye appears to be focused on a single point.
   3. Regressions. Right-to-left movements from points on a printed line.
   4. Duration of movements. The amount of time in which the movements and fixations occurred, reported in milliseconds.

C. Good readers - Seventh-grade pupils who achieved scores above the 84th percentile on the 'Reading Comprehension' battery of the Iowa Test of Basic Skills.

D. Poor Readers. Seventh-grade pupils who achieved scores within the percentile range of 15 to 30 on the aforementioned test.

The Problem

The question to which this study was directed was whether there was an observable difference between good and poor readers with respect to the manner in which they looked at or inspected cloze materials. Stated as a formal hypothesis, in null form, the question becomes:

> There will be no significant change in the number of regressions and the number of fixations which good readers exhibit when reading cloze materials from the number of regressions and fixations which they exhibit when reading comparable material without deletions. There will be no significant change in the number of regressions and the number of fixations which poor readers exhibit when reading cloze materials from the number of regressions and fixations which they use when reading comparable materials without deletions.

Design and Procedures

Two groups of seventh-grade pupils were randomly selected from two stratified populations; those students whose achievement scores were above the 84th percentile on the Reading Comprehension battery of the Iowa Test of Basic Skills and those students whose scores fell between the 15th and the 31st percentile. Fourteen were in each group.

Two days before the experimental treatment, all Ss were exposed to two junior high school level paragraphs from the EDL test materials which are normally used to observe eye movements with the Reading Eye II, a device which records eye movements. The selections were cloze-treated with every sixth word deleted. Ten true-false questions were presented after each selection.

After this training session, the Ss were singly taken to the testing site (in the middle-school which they attended) and asked to read two additional selections from the EDL paragraphs while using the eye movement camera. The selections were not treated with the cloze procedure. This initial part of the treatment was to acquaint the Ss with the apparatus. Then each subject was asked to read one cloze-treated selection and one non-deleted selection. The print-out of the eye movements was kept for analysis. Following each selection, ten true-false questions

were presented. The questions were used as an attempt to hold the Ss' attention and were not considered as data for analysis. The Ss were chosen alternately from each group, and the order of test selections was also alternated.

The tapes which constituted the record of the eye movements of each S under each condition--reading one cloze passage, and one non-deleted passage--were then analyzed by counting the total number of fixations and regressions. The duration of the fixations was estimated, but the possible error with this apparatus is so great that little confidence can be placed in the result. However, the averages will be discussed below.

Repeated measures analysis of variance were used on measures of the mean number of fixations and the mean number of regressions to test for the ability of the reader and the type of materials being read, and for interaction affects Newman-Keuls posttests were performed to compare individual means when interaction effects were found to be significant.

Results

An analysis of the records of the fixations used by both groups under each condition indicated that good readers used fewer fixations when reading normal materials than did poor readers, but that they used more fixations when reading cloze materials. The poor readers actually used fewer fixations when reading cloze materials than when reading normal materials. The mean numbers of fixations of each group under each condition are shown in Table 1.

Insert Table 1 about here

An ANOVA indicated that main effects, the ability of the students, was not significant. However, the interaction effects of ability and type of material was significant at the .01 level of significance. The direction of the interaction is

indicated in Figure 1.

Insert Figure 1 about here

Obviously, similar results might be expected from an analysis of the data for regressions, since the regressive movements which the apparatus is capable of recording generally have fixations as end-points. The main effects of ability were not significant. The interaction results are presented in Table 2. Again, the good readers used fewer regressions when reading normal materials than did poor readers; and, again, they used more regressions when reading cloze materials. Likewise, the poor readers used more regressions when reading normal materials and fewer when reading cloze materials, fewer than when they read normal materials.

Insert Table 2 about here

The direction of the interaction is shown in Figure 2.

Insert Figure 2 about here

While the probable error in measurement of duration is too great to draw any precise conclusions, it seems probable that the duration of the fixations of good readers under both conditions was shorter than the duration of the fixations of the poor readers. It also seems probable that duration of the fixations of both groups was longer when reading cloze materials. The means are indicated in Table 3.

Insert Table 3 about here

Discussion

The way in which good readers reacted was hardly unexpected. Their behavior seemed to confirm the descriptions of the search procedure suggested by Weaver (1969), Taylor (S. Taylor, 1960), Boyle (1942) and many others. It seems reasonable to speculate that good readers employed strategies similar to those which Bruner, Goodnow and Austin (1956) called 'high-risk focus gambling' and 'conservative focus-gambling.' Given the expectation that their inferences were correct, they used a minimum number of fixations and regressions. When their inferences were incorrect, they adjusted their hypothesis and re-evaluated information to fit the new hypothesis. (This is not demonstrable, of course, and, as aforementioned, is pure speculation.)

The interpretation of the behavior of the poor readers should be approached very cautiously. The difference in behavior between good and poor readers under the cloze treatment does not prove or disprove the existence of different selection strategies. Good and poor readers differ in many other ways, which can be demonstrated more rigorously. It could be argued that the materials used were at a level of difficulty which quickly made the task meaningless to the poor readers. Yet, in a companion study, the senior writer found similar results when single sentences of varying complexity were read. Poor readers made no more fixations and regressions when reading transformed sentences than when reading kernel sentences, while good readers increased the number of regressions and fixations when reading more complex sentences (Heiner, 1972). As Blanchard laconically suggested, poor seem to have 'more efficient' eye movements than good readers (Blanchard, 1952) in that they tend to be uniform throughout a passage, regardless of the nature of individual sentences and lexical ideas.

The tentative inference which is offered here is that the poor readers

observed in this study use a single strategy for processing information which they do not readjust by reevaluating information, but, rather which they intensify by extending the duration of their fixations when they encounter cloze materials. The actual decrease in fixations under the cloze treatment seems to add some weight to this inference. The deletions reduced the amount of direct information, and, therefore, fewer but longer fixations were used.

It is beyond the writers' competence, confidence, and interests to speculate further about the significance of this phenomenon.

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Table 1

Mean Number of Fixations

Good Readers		Poor Readers	
Normal	Cloze	Normal	Cloze
98.29	112.72	120.08	105.15

Table 2

Mean Number of Regressions

Good Readers		Poor Readers	
Normal	Cloze	Normal	Cloze
16.00	27.36	25.79	22.56

Table 3

Mean of Average Durations

of Fixations in Milliseconds

Good Readers		Poor Readers	
Normal	Cloze	Normal	Cloze
725	800	875	950

Figure 1

Mean Number of Fixations Within Types

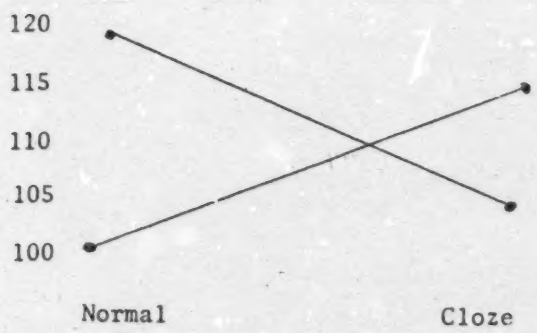

Figure 2

Mean Number of Regressions With Types